DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

Vol. 17, No. 1 | January 1965

Gordon D. Goldstein, Editor
Margo A. Sass, Associate Editor
Judy E. Ceasar, Editorial Assistant
Judy A. Hetrick, Editorial Assistant

CONTENTS

Approved by
The Under Secretary of the Navy
25 September 1961

NAVSO P-645

32

Editorial Policy Notices

EDITORIAL

The Digital Computer Newsletter, although a Department of the Navy publication, is not restricted to the publication of Navy-originated material. The Office of Naval Research welcomes contributions to the Newsletter from any source. The Newsletter is subjected to certain limitations in size which prevent publishing all the material received. However, items which are not printed are kept on file and are made available to interested personnel within the Government.

DCN is published quarterly (January, April, July, and October). Material for specific issues must be received by the editor at least three months in advance.

It is to be noted that the publication of information pertaining to commercial products does not, in any way, imply Navy approval of those products, nor does it mean that Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. Your contributions will provide assistance in improving the contents of the publication, thereby making it an even better medium for the exchange of information between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to the editor for future issues. Material for specific issues must be received by the editor at least three months in advance. It is often impossible for the editor, because of limited time and personnel, to acknowledge individually all material received.

CIRCULATION

The Newsletter is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

For many years, in addition to the ONR initial distribution, the Newsletter was reprinted by the Association for Computing Machinery as a supplement to their Journal and, more recently, as a supplement to their Communications. The Association decided that their Communications could better serve its members by concentrating on ACM editorial material. Accordingly, effective with the combined January-April 1961 issue, the Newsletter became available only by direct distribution from the Office of Naval Research.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

GORDON D. GOLDSTEIN, Editor
Digital Computer Newsletter
Informations Systems Branch
Office of Naval Research
Washington, D. C. 20360

Computers and Data Processors, North America

Burroughs B5500

Burroughs Corporation
Detroit, Michigan 48232

In August 1964, the Burroughs Corporation announced a new, modular electronic data processing system of advanced logical design—the B5500—which has up to three times more productive capacity than the B5000.

The powerful B5500 integrates fast, new hardware with a unique, automatic controlling and operating system, providing full real-time capabilities. Developed from proved-in-use design, the system is effective and economical in both commercial and scientific applications. Deliveries of the new system, which spans the medium to large scale computer range, will begin in 6 months.

The high "throughput" of the B5500 is the product of four major abilities of the new system:

1. Multiprocessing techniques permit simultaneous handling of two or more programs. For example, while printing out the results of one job, the computer can perform computation on other, different problems and take in raw data on still another task.

2. Simpler and less costly programming is made possible by exclusive hardware/software features that enable the B5500 to compile, rapidly, efficient programs written in languages for business data processing and for scientific and engineering problems.

3. The Master Control Program, the most complete, most advanced, most tested automatic operating system ever used to control and schedule computer operations, virtually eliminates human error and uses the computer itself to assure efficient operation.

4. The modular design of the B5500 permits expansion or contraction of the system at any time without the need to write new programs. The B5500 can grow, for example, from a medium size system with a single processor to a very large, dual-processor system with nearly a billion characters of memory. The MCP balances the program "mix" against the hardware configuration and operates the computer in a manner that gets the greatest efficiency from all modules and peripheral devices.

Among important new components and features of the B5500 are:

- The new central processor with faster computational operation, improved logic, and new, more expanded instructions to control the routing of electronic impulses.

- The new memory unit which can manipulate a character of information in 250 nanoseconds (billionths of a second).

- FORTRAN II, FORTRAN IV, and ALGOL languages for scientific and engineering problems, and COBOL language for business data processing.

- The maintenance test logic, a major innovation in system maintainability which provides a test routine for every logical operation.

- The on-line disk file subsystem which can provide electronic access to any record in an average of 1/50 second.

- The full data communications network capabilities including Dial TWX, Teletype, inquiry typewriter, and other terminal units.

The revolutionary Burroughs on-line disk file subsystem fully complements the advanced system concepts of the B5500. With its "head-per-track" design, the disk file provides simplified file organization, programming, and use because access to data is entirely by electronic switching. Each record segment is equally available regardless of physical location on the disks.

A disk file subsystem can be expanded from one unit with a capacity of 9.6 million characters of information to 100 units, extending the memory of the computer system by almost a billion characters.

Experienced technical support teams have been chosen from Burroughs large systems group to assist B5500 users in the effective application of the system to their data processing work. These teams, expert in large systems utilization and in the use of advanced programming languages, have been especially trained in the advanced organization of the B5500. They will serve the country from Burroughs district offices.

A full B5500 system capable of running the complete line of software described earlier can be leased for under $20,000 a month or purchased for $830,000. A typical large scale two-processor system can be leased for approximately $35,000 per month or purchased for $1,473,000. Purchase price for a maximum system is more than $5,000,000.

The B5500 is a new, advanced information processing system programmatically compatible with the B5000. The integration of hardware and software which permitted the B5000 to be the first system in operation with practical multiprocessing now included on the B5000:

NEW OPERATORS

The instruction repertoire of the B5000 includes 19 new operators which are designed specifically to increase the execution speed of the Master Control Program, the compilation of programs written in COBOL, FORTRAN, or ALGOL, and the execution of the compiled object program. These new operators affect every phase of B5500 operation including input-output operations, memory allocation, and overlay, general system performance, disk-file operation, and parallel processing with dual processors.

MEMORY FETCH OVERLAP

The new memory on the Burroughs B5500 provides virtually complete Fetch-Overlap. This means that the fetch portion of a syllable, or of a program word, is overlapped with the execute portion of the previous word or syllable, permitting memory read access at a rate of 250 nanoseconds per character or 2 microseconds per word. No other computer in its class offers this effective speed advantage to its users.

MAINTENANCE TEST LOGIC (MTL)

New operators included in the B5500 are specifically designed to simplify and broaden the scope of maintenance software. Now proven techniques . . . developed through years of experience in fail-safe military systems technology . . . give every B5500 user more system availability by significantly reducing the time to locate trouble.

Maintenance Test Logic, combined with a maintenance test routine, makes possible complete diagnostic checkout procedures to give the field engineer the ability to pinpoint any trouble source and to correct it in far less time than with the procedures presently employed with other systems.

This hardware-software approach to diagnostic checking . . . providing a test for every logical operation the system is capable of performing . . . makes possible a new level of system maintainability.

MTL permits total system testing during each scheduled maintenance period, eliminating the partial logic testing now employed to keep running time within reasonable limits. This overcomes a fault inherent in all other systems without MTL.

PROVEN DUAL-PROCESSOR OPERATION

One or two of the new, fast processors are available on the B5500. Experience with two processor B5000 operations in customer locations indicates that as much as 80 percent more work can be accomplished by the addition of the second processor for only a 12 percent increase in system price. These money-saving increases in productivity are available with the new, faster B5500.

EXTENSIVE PROGRAM LIBRARY

Because the B5500 is completely compatible with the B5000, all of the library programs now available to B5000 users can be used immediately by B5500 customers. This includes a complete and sophisticated package of scientific and technical routines in the fields of Numerical Analysis, Engineering Physics, Petrochemistry, Civil Engineering, Electrical Engineering, Statistics and Operations Research. Included in the latter group is an advanced Linear Programming System. Providing the B5500 with the latest techniques in today's most rapidly expanding operations research tool, Burroughs Linear Programming System offers such useful features as:

- Parametric programming options;
- The ability to solve multiple objective functions, or multiple right-hand sides with one set of constraints;
- Re-inversion options to preserve accuracy.
- Matrix analysis to pre-determine problem feasibility;
- Row-selection techniques for sub-optimization;
- Error checks; and
- Complete solution print-outs, including cost ranging.

IBM System/360 Model 92

International Business Machines Corporation
White Plains, New York 10601

International Business Machines Corporation announced in August 1964 that it will develop and build an ultra-high performance model of its System/360 (see Digital Computer Newsletter, October 1964). The new machine will be known as the IBM System/360 Model 92. System/360 was announced early in 1964 as a single system that will span the performance range of virtually all current IBM computers. Model 92 represents a major extension of this system in terms of its computing power. IBM will enter into special contracts for various configurations of System/360 Model 92 which are based on a user's particular computing needs.

Three factors which will make the Model 92 suitable for solving scientific and research problems of great size and complexity are:

- High Operating Speeds. The Model 92, executing floating point instructions, will be able to add two numbers in 180 nanoseconds (billionths of a second) and perform a multiplication in 270 nanoseconds.
- Memory Capacity and Speed. Up to 131,072 words of information will be available in the Model 92's main core storage. Each of these words will be 64 bits in length. A word will be available for use in one-half microsecond (millionth of a second). Interleaving techniques will further enhance the speed of memory. In addition, up to 2 million 64-bit words of additional high-speed, directly addressable core storage will be available.
- Parallel Operations. Design advances in parallel operation will enable the Model 92 to execute logical and arithmetic operations simultaneously, contributing to the system's efficiency in solving problems involving millions of individual steps. The processor is designed to execute many instructions concurrently, including up to three floating-point arithmetic operations.

Cost of the System/360 Model 92 will vary depending on the peripheral equipment required in individual configurations. Cost of the central processing unit with 65,536 words of main core storage will be $4,380,000. Monthly rental will be $106,000.

Program Support for IBM System/360

International Business Machines Corporation
White Plains, New York 10601

INTRODUCTION

Programming support for the IBM System/360 (see Digital Computer Newsletter, October 1964) includes a comprehensive package of programs designed to speed implementation and assure efficiency of each installation.

IBM will supply users of the new computer system with compilers such as FORTRAN IV and COBOL and programs such as sort/merge and utility programs. All are designed for operation under a comprehensive monitor or control program. The control programs handle job-to-job transition, control of input and output units and other functions which formerly had to be executed by the computer operator.

Included in System/360 program support will be a compiler for a new program language which will combine FORTRAN-type mathematical statements with the ability to handle complex logic and data manipulations.

The IBM System/360 is a powerful computer, able to perform more work in a given time than its predecessors. Because of this, it is important to keep the system busy with work . . . and minimize manual interruptions. Were the computer halted after each batch processing task, it might lose as much as half of its productive time, while new cards were loaded, or other setting-up operations were being performed.

The objective is to have the computer schedule itself, so that it can operate continuously, with little or no manual intervention. This concept of operation—the operating system concept—will be made possible in System/360 by a group of control programs that handle the transition from one job to another and supervise the use of all input and output equipment.

IBM will supply programs to System/360 users in a format that will enable them to select those portions that will give them a custom-organized operating system. In addition, IBM will provide a group of programs to operate in a more conventional operator-controlled environment.

Control programs contain many routines that would otherwise have to be put into each individual program. Such routines include those for handling error conditions, interruptions from the console or interruptions from a communications terminal. There are also routines for handling input and output equipment. Because these routines are pre-written, the programmer is saved a good deal of effort and the likelihood of programming errors is reduced.

Expandable System

Users will be able to expand their System/360 capability simply and efficiently by the introduction of faster processing units, or of higher performance input and output equipment, or by expanding channel capability. This can be done while maintaining the validity of existing programs. Many of the processing programs and compilers will be available in several sizes to provide more efficient operation as an installation grows in size.

Input/Output Referencing

References to data on tape or disk will be made symbolically. Instead of describing the address of a certain disk or tape, the programmer will refer to such data with a functional name. This means the programmer need not keep in mind where data will be coming from.

It also means that there is a good deal of flexibility for the machine operator. He can mount tapes in the most efficient way each day. The control programs set up an input and output assignment table which indicates the whereabouts of data files. These tables are used as directories when programs are run.

This flexibility helps the operator schedule work so that jobs can be loaded, tapes mounted and disk packs attached before a job is called by the control program.

Modularity

Operating system programs conform to specific standards, so that control programs will have an identical interface with all processing programs. These standards are well documented so that user-written programs can follow the same conventions. The user is free to supplement IBM-supplied programs to meet special situations. By following the rules indicated in the standards, portions of control or processing programs can be changed or replaced in modular fashion.

PROCESSING PROGRAMS

Processing programs actually accomplish work such as updating inventory records, preparing reports and compiling new programs. They include both support programs and application programs. The application programs will be written making use of FORTRAN and COBOL and the macro-statements of the assembly program wherever possible. Support programs include the following IBM-written packages:

COBOL

The COBOL language provides a convenient method of coding commercial-type programs. Among the instructions the COBOL programmer can use are input/output, arithmetic, data manipulation, sequence control, and directions to the compiler itself. The compiler accepts COBOL language programs and produces object programs which may be loaded into the System/360 for execution.

COBOL language is concise and well-defined, with all the important capabilities implemented in previous IBM COBOL compilers. Its usefulness is enlarged, optionally, by the ability to handle sub-programs, report writing, sorting, mass storage, and communications.

FORTRAN

The FORTRAN IV language allows the programmer to code a mathematical or scientific problem in terms closely resembling those he uses in stating the problem mathematically.

The FORTRAN compiler translates the user's program directly from FORTRAN into machine language. When compilation is completed, the resulting program may then be loaded into the System/360 for execution. The compiler includes diagnostics that list language statement errors in the work of the programmer.

New Program Language

The new program language will provide, in addition to a FORTRAN-like mathematical capability, facilities such as the ability to define and operate on character strings and bits, permitting the user to handle a variety of input data. It will also offer facilities for handling complex logical requirements such as those in information and control systems.

Assembly Language and Program

The assembly language for the IBM System/360 is a symbolic language that permits the coding of source programs in convenient, easily understandable terms.

The assembly program is available in several levels designed to best meet specialized application needs of an installation according to the storage available. The assemblers range in capability from simple one-for-one statements to a full macro-instruction language.

Report Program Generator

The report program generator provides a convenient programming method for producing a wide variety of reports. These may range from a listing of a card deck or magnetic tape reel to a precisely arranged, calculated, and edited tabulation of data from several input sources.

Utility Programs

The System/360 utility programs provide the user with standard methods of handling such input and output transfer operations as: card-to-tape, tape-to-disk, and tape-to-tape.

Sort/Merge

The System/360 sort/merge program is designed to satisfy the sorting and merging requirements of tape or random storage-oriented IBM System/360 installations. It is a generalized program that can produce many different sorting or merging programs in accordance with control information specified by the user.

CONTROL PROGRAMS

One of the distinguishing features of the IBM System/360 is the philosophy of computer control designed into control programs. System/360 usually will be under control of a supervisory program. This philosophy makes it possible to operate the computer automatically and have it able to respond to real-time demands from remote terminals and control equipment.

The portion of the control program which starts job operations, assigns input/output units, and performs functions needed to proceed from one job to another is the job processing control.

When System/360 is started, the job processing control program establishes control over all input and output units. It then starts processing program operation according to the schedule established by the operator. The loader is able to combine separately assembled program segments into a single program at program execution time.

Another part of the basic control function is performed by the program execution control. When an interruption occurs, it is the program execution control which determines the nature of the interruption and the appropriate action to be taken. The program execution control determines relative priority of programs ready to run and loads other programs into storage.

Librarian Program

The librarian program portion of the control function provides for maintenance of library programs used as part of the operating system. The library may be stored on a single secondary storage unit or it may be distributed over several different storage units. In either case, the librarian program keeps this library up to date by adding, deleting, and modifying as required. User-written application programs can be incorporated into the library along with subroutines, the control program itself, compilers, sort/merge, and utility programs.

Input/Output Control

There are several portions of control which direct interactions between the processing unit and input and output equipment. One is written to control actions with tape, card and printer equipment. The second control is specifically designed for random processing of records stored on direct access devices. It is a separate control in order to minimize seek times. Another group of control routines will be available to handle remote terminals and the processing of messages.

NCR 315 RMC (Rod Memory Computer)

The National Cash Register Company
Dayton 9, Ohio

The first commercially available data processor with a main memory made entirely of thin-film storage elements was announced in July 1964 by the National Cash Register Company.

Designated the NCR 315 RMC (Rod Memory Computer), the general-purpose system can execute approximately 100,000 instructions per second and control a wide variety of input/output equipment geared to the changing needs of the user.

The unique main internal memory is fabricated from cylindrical thin-film, rod-like magnetic storage elements rather than from conventional doughnut-shaped ferrite cores. It can store up to 240,000 decimal digits (4 data-bits each) or 160,000 alphanumeric characters (6 bits each). The basic cycle time is only 800 nanoseconds (billionths of a second). Average access time per digit is 267 nanoseconds.

The Rod Memory Computer is the newest addition to the 315 data processor series (see Digital Computer Newsletter, July 1961). Through NCR's proprietary Rod developments in thin-film technology, a main memory of unparalleled speed and reliability is now available for 315 users, both current and future.

The new data processor and its associated memory unit are compatible with all existing 315 peripheral equipment and software, thereby permitting users of standard 315 or 315-100 computers to increase the performance of their systems whenever desired.

A new line of higher performance peripherals is available with the 315 RMC, including a 120-kc magnetic tape handler, a 1000-line-a-minute printer, a 250-card-a-minute card punch, and a data communications controller for expanded on-line processing capability. The new peripherals also can be used with standard 315 and 315-100 computers.

Also announced were two new higher capacity CRAM (Card Random Access Memory) units, with capacities of 8- and 16-million characters respectively and transfer rates of 38 kc.

It is emphasized that all existing and extensively tested programs for NCR 315 and 315-100 computers can be run "as is" on the new system without recourse to costly modification. The new system also accommodates such 315 programming aids as COBOL and NCR's recently announced BEST program generator. BEST can cut programming time for many business data-processing tasks by approximately one-half.

Although it is designed primarily for business applications the 315 RMC has built-in floating-point arithmetic, will be available with FORTRAN, and is a well-balanced scientific and engineering data processor. The basis system will handle from one to eight of the new high-density 120-kc magnetic tape units. With the addition of magnetic tape controllers, up to 16 tape units can be used on-line with the processor for simultaneous reading, writing, and computing.

Internal speeds of the new Rod memory are some eight times faster than a comparable standard 315 core memory, the company said. The basic memory storage element is a hair-like beryllium-copper wire which has been electroplated with a nickel-iron magnetic film, using precisely controlled automatic production techniques. This film completely surrounds the wire substrate and is 4000 angstroms thick. An angstrom unit is a ten-millionth of a millimeter.

The plated wire is cut into desired lengths and assembled in a three-dimensional array to form the completed memory. In the computer, electrical pulses sent through microscopic coils in the memory stack magnetize the film

in predetermined directions and at predetermined locations. Information, in the form of pulses, can then be read out of the memory by sensing the magnetic state of the cylindrical thin film at any given location in the array.

This memory concept eliminates the stringing of magnetic cores on wire grids. Since the thin-film Rod can be mass-produced and easily assembled, it results in relatively low production costs for an ultrafast, reliable memory system.

The cylindrical thin films utilized in the 315 RMC represent the first commercial application of thin-film technology to a computer's main memory. Usage of other types of thin films for computer memories has thus far been confined to relatively small "scratch-pad" memories.

The 315 RMC comes equipped with a basic 60,000-digit memory which can readily be expanded to 240,000 digits in increments of 60,000 to meet increased storage needs. The modular design is in keeping with NCR's "expand-when-needed" concept which permits all 315 systems to grow with the user's changing requirements.

Complementing the speed of the new memory is the design of the central processor. It employs high-performance silicon solid-state circuits which are packaged on condensed plug-in boards requiring a minimum of wiring. Since the circuits take up little space, the entire central processor-control console (including input/output typewriter) is housed in a desk unit measuring only 3 by 5-1/2 feet.

Up to 16 of NCR's unique CRAM magnetic card memory files can be integrated into the new computer series to provide additional random-access storage.

Other inputs may include punched card, paper tape, magnetic character, and optical readers. Available outputs include up to four high-speed printers and card punches in any combination on-line to the processor, a paper tape punch and magnetic tape units.

"Save" and "restore" instructions in the 315 RMC system allow various peripheral equipment operating off-line to interrupt the main program of the computer on a priority basis, exchange information with the computer, and return the computer to its original program at the point of interruption, thus reducing the complexity of the program.

A 315 RMC processor and memory with a capacity of 60,000 digits will rent for $6,000 monthly. This compares with $4,800 to $5,150 for standard 315s with comparable memory capacity.

The 315 family of computer systems extends from the 315-100 series starting at $3,575 monthly rental for a basic magnetic tape system to over $20,000 monthly, depending upon the utilization of the wide range of peripheral equipment available.

First deliveries of the 315 RMC are scheduled for mid-1965.

The basic elements in NCR's solenoid-accessed Rod-type memory are tiny metal rods which are coated with a thin film and wrapped with wire windings.

Aside from performance and reliability advantages, the new Rod memory features relative ease of assembly and manufacture. In an automatic and continuous sequence, beryllium-copper wire is plated with nickel-iron thin film by continuous-process electrodeposition. Solenoid planes are fabricated with coils automatically wire-wound in place, and the finished rods are inserted into the coils, passing through a stack of aligned planes.

The completed memory stack is about half the size of a comparable standard 315 core memory. Its random access cycling time is 800 nanoseconds (billionths of a second) an entire order faster than conventional microsecond computer memories.

The cylindrical structure of the Rod facilitates the use of multiple-turn windings, which minimizes the usual problems associated with thin magnetic films. Also, the cylindrical shape allows for tight coupling between windings and magnetic material. Thus, large switching fields can be provided with reasonable currents and small inductances. Because the Rod is adapted to three-dimensional winding fabrication, windings can be organized to minimize crosstalk problems in high-density memories.

A 20,000-word Rod memory is composed of eight modular units, composed of 40 solenoid planes and 1056 Rod elements. Each solenoid plane contains 16 rows of 66 serially connected solenoids, spaced on 1/8-inch centers in each of the three-dimensional planes. This organization provides a packing density of 512 bits per cubic inch, excluding the solenoid frames.

The new Rod memory has been under development for several years at NCR's Electronics Division in Hawthorne, California.

The cylindrical thin-film Rod meets the following requirements for an ideal computer memory element:

- It is compatible with other system components;
- It is easily fabricated with stringent process control and economy through a continuous fabricating and testing procedure;
- It is insensitive to environment; and
- It operates at high speed.

NCR pointed out that since the 315 RMC was developed as part of the company's 315 computer family, an RMC processor and memory can be used to expand the capability of existing 315 systems in those installations where increased performance is required. All previously developed 315 programs and software can still be used.

Designed for multi-computer installations, or installations requiring greater speeds, the RMC processor and memory operate with either standard 315 peripherals or with the company's newly announced higher-speed 315 peripherals.

Computing Centers

MEDLARS-Information Retrieval System

National Library of Medicine
Washington 25, D.C.

The world's largest medical information storage and retrieval system began operations in June 1964 at Bethesda, Maryland.

The National Library of Medicine (NLM) reports its unique information retrieval system called MEDLARS (Medical Literature Analysis and Retrieval System) is now on-line. The system's primary function is to exploit a single information input to produce multiple printed outputs having at least five times as much information as originally entered.

MEDLARS, a $3-million system built around a large-scale Honeywell 800 computer, is one of the first applications of electronic data processing techniques to complex problems of scientific information handling in a library.

INFORMATION EXPLOSION

NLM began developing the MEDLARS concept in 1960 in an all-out effort to control an information explosion that had been threatening to engulf the medical sciences.

This year, for example, NLM will be indexing more than 16,000 issues of medical journals containing an average of 10 articles each on subjects ranging from abdominal disorders to zymomonas. By 1970, the library expects to be receiving 25,000 issues a year containing about 250,000 articles.

More than 300 medical journal issues are received each week at NLM for MEDLARS. They are distributed to the indexing staff for selection of articles, translation of foreign article titles, and indexing of each article with appropriate descriptors from NLM's controlled list of terms called MeSH (Medical Subject Headings).

The resulting unit records for each article— comprising regular bibliographic citations plus associated MeSH tags that describe as completely as possible each article's content— are entered onto perforated paper tape and fed into the Honeywell 800. The computer processes, compresses, and stores the records on magnetic tape.

INDEX MEDICUS

Although MEDLARS has a number of tasks to perform, including the answering of demand search requests and preparation of recurring bibliographies on specialized medical subjects, its primary job is preparation of Index Medicus.

Index Medicus is NLM's massive monthly bibliography of the world's medical literature and contains approximately 12,000 citations in an average 500-page issue. It is "must reading" for MD's trying to keep abreast of latest developments in medical research and practice.

Once a month, the Honeywell 800 edits and completely cross-references all unit records stored in it during the previous 4 weeks. It then stores this information on magnetic tape for input to a unique optical output device called GRACE (Graphic Arts Composing Equipment). GRACE automatically translates the computer's output into high-quality photo-copy from which the final printing plates are made, printing complete pages at a rate of 300 characters a second (from a font of 226 characters) on positive photographic film or paper.

GRACE is being used to compose Index Medicus, Cumulated Index Medicus, and other recurring bibliographies requiring typographical variations and graphic excellence. Before GRACE was available, these publications were prepared on the Honeywell 800's high-speed printer using 16-pound heat transfer paper with a one-time Mylar ribbon.

MEDLARS, which prepared Index Medicus for the first time in January, has helped reduce to less than 10 days the total throughput time needed to produce the volume; a number of days less than it normally would have taken NLM's expert staff to accomplish the same job. Actual computer time amounts to less than 3 hours.

IBM 7094 Model II

Institute of Computer Science
University of Toronto
Toronto, Ontario, Canada

With the expansion of its 2-year old IBM 7090 to a 7094 Model II this fall, the Institute of Computer Science continues to meet the ever-increasing demands of Canadian University educational and research programs. Current projects total over 400, 72 from 10 outside universities and 331 from almost every department within the University of Toronto. Some 700 staff and student members are trained annually in the fundamentals of computer programming, chiefly with the aid of Canned FORTRAN lectures. Advanced training is also available at the University of Toronto. A 1-year Diploma Course in Computing and Data Processing continues to be offered in 1964-5. With the inauguration of the Department of Computer Science in the School of Graduate Studies, the University is now offering programs for the degrees of M.A. and Ph.D. in Computer Science. Fields of study include numerical analysis, information retrieval, programming language development, and artificial intelligence. Full-time professors appointed to the new department include Dr. C. C. Gotlieb (Head), Dr. J. N. P. Hume, Dr. T. E. Hull, Dr. Beatrice H. Worsley, and Dr. W. Kahan. Cross-appointments with other University Departments are also being established.

Burroughs B5000 for Research and Cadet Training

U.S. Air Force Academy
Seiler Research Laboratory
Colorado Springs, Colorado

The Frank J. Seiler Research Laboratory is installing a Burroughs B5000 electronic data processing system in its facility at the USAF Academy. The Seiler Laboratory is a part of the Air Force Office of Aerospace Research in Washington, D. C. The B5000 will be used in support of Air Force fundamental research programs, for cadet training and scheduling.

"Every young Air Force officer is bound to come in contact with computer applications during his career," says Major William D. Marsland, Jr., who is in charge of the B5000. Major Marsland is director of the computer division of the Frank J. Seiler Research Laboratory. Personnel of the Seiler lab will share research use of the computer with Academy faculty members and outstanding students.

Since September 1964, the number of cadets taking computer courses increased from approximately 200 to about 400 per semester. At least two computer courses were set up. One course was set up primarily for cadets whose main interest is in science and engineering. The other was for the management-oriented.

Installation of the high-speed, solid-state equipment will enable the Academy to make computer applications a required course for graduation.

The decision to make computer applications a prerequisite for graduation was based upon the increasing use of computers throughout the Air Force—in missile and satellite control systems, in command and control systems, supply and logistics, weather prediction, intelligence, personnel records, and payroll.

The Academy, with an enrollment of 2500, trains young men for military leadership in the Air Force. It offers academic, military, and physical education courses. Upon graduation, the cadet receives a Bachelor of Science degree and a commission of second lieutenant in the regular Air Force.

"Before each of the cadets graduates, it is essential that he has an understanding of the capabilities and limitations of computers, even if he will not be directly involved in their operation," Major Marsland said.

The only computer now at the Academy is a small machine, already carrying a heavy load of business data processing; however, it has been available for cadet training, via several elective courses, and some research use. In addition, the Academy uses the Western Data Processing Center at the University of California at Los Angeles, and is linked to the computers there via a data communications system.

The $1 million computer system being purchased from Burroughs Corporation includes two central processors; one 12,000-word high-speed magnetic core memory unit; four magnetic tape transports; one 800-card-per-minute reader; one 700-line-per-minute printer; one 300-card-per-minute punch; and a 32,000-word magnetic drum memory unit.

Auxiliary equipment will include a Calcomp 570A Magnetic Tape Unit and a 565 Plotter. This produces graphic representations of computer data directly from B5000 output tapes.

The B5000 system is modular. Thus, as the workload grows, the system can be expanded without reprogramming.

The mission of the Seiler Laboratory is basic research in chemistry and aerospace mechanics. Some of the lab's applications which will be placed on the B5000 include three-body orbital problems; a series of mathematical comparison programs; data reduction of measurements made from X-ray photos and diffraction patterns of compounds; simulation of an analog computer on the B5000 so that it can either substitute for an analog machine or be used with analog data to get more accurate results than an analog computer can provide; shock wave structure studies, and analysis of a mathematical model representing diffusion of liquids or gasses through porous material.

Air Force Academy faculty members also have several research projects which will be placed on the Burroughs computer. These include: studies of the trajectory of both powered and non-powered missiles in an effort to determine optimum use of power; statistical studies of officer effectiveness reports and the whole Air Force officer rating system; studies of evaluation and selection test results to try to identify the men who really want military careers; statistical studies of economics; war games; management studies; Critical Path Methods; data reduction from stress analysis studies; and thermoelectrical studies.

In areas of cadet scheduling, the B5000 will be used to check prerequisite courses, substitute courses, the number of hours the cadet is carrying, his grades, and so forth. Eventually, the computer may be used to assign classes. All cadets, even those with some college background, spend a full 4 years at the Air Force Academy. It has a flexible schedule which permits a student with college credits to take more advanced courses. And, although the Academy does not give advanced degrees, it does have working arrangements with some universities so selected cadets can do graduate work.

In preparation for installation of the new computer, the Seiler Research Laboratory and Academy staffs have been using a B5000 at the Marathon Oil Company's Denver Research Center about half-a-day a week to check-out programs that the Academy and laboratory will use and also to become familiar with the computer and its capabilities.

Training courses for research personnel and faculty members are underway too, both to "teach the teachers" and encourage the faculty and researchers to use the new machine.

THE BURROUGHS B5000 CONCEPT

The B5000 system has been designed from the standpoint of the user's problems rather than from any hardware preconceptions. The B5000 incorporates revolutionary logic and language developed concurrently with programming and operating systems. This makes the B5000 easier to use and yet far more productive, since it employs a total system approach to computing and data processing problems. Included are:

- Built-in automatic programming systems, including compilers for ALGOL, COBOL, and powerful extensions of both.
- Processors specifically designed to make most effective use of these automatic programming systems.
- A Master Control Program to manipulate machine programs automatically, allocate memory, assign equipment, and route all information.
- New equipment features specifically designed to enable the Master Control Program to utilize all system components with an unprecedented degree of automatic control and efficiency.

For example:

Programs are automatically segmented during compilation to conserve memory and expedite processing.

Programs are independent of memory locations.

Flexible communication is provided between all major component groups, and powerful interrupt logic permits the simultaneous performance of multiple independent functions.

The Seiler Laboratory B5000 includes:

Processors

Two parallel, independent, solid state processors, each with a 1-megacycle clock rate with average add execution time of 3 microseconds.

Processors operate on 49-bit words (48 bits plus parity bit) which may be interpreted in binary or alpha-numeric form with common fixed-point and floating-point number representation. Instruction format: 12-bit operators or addresses, packed four to a word, executed sequentially with generalized indexing ability. Internal operation is word and/or character oriented.

Memory

Six high speed, coincident-current, magnetic core modules with read access time of 3 microseconds and 6 microsecond memory cycle. There are 4096 49-bit words per module. Each memory module has its own access address register, permitting simultaneous access by processors or input/output control channels.

Input/Output

Two magnetic drums (capacity 32,768 49-bit words each) provides fast random access bulk storage. Read-write rate: 8.1 microseconds per character.

Input/Output Control Channels

One to four independent input/output control channels may be used. Any of these channels may interconnect any memory module and any input/output device. With four channels in use, four input/output operations may be performed simultaneously with computation.

The Seiler Laboratory computer initially will have two input/output channels.

Input/Output Devices

Four magnetic tape transports with operating speeds of 66,660 or 24,000 characters per second, reading backward or forward at 120 inches per second. Rewind speed: 340 inches per second. Packing density: 555.5 or 200 character frames per inch. Reel capacity: approximately 24 million alphanumeric characters. Dual-gap read-write heads provide longitudinal and vertical parity checking. Data may be either in single-frame alphanumeric or binary form.

A 120-position wideline drum printer which operates at 650 lines per minute, double spaced; over 700 lines per minute, single spaced. It accepts Burroughs Common Language, binary-coded alphanumeric information from any input/output channel into a 120-position buffer, and has an immediate access print cycle. The print drum contains 64 characters per position. Spacing: 10 characters per inch horizontally; 6 or 8 lines per inch vertically.

An 800-card per minute reader with photoelectric sensing utilizes an immediate access clutch and reads data in either standard punched card or binary form. Read circuitry is automatically monitored and invalid character recognition is provided.

A parallel card punch which operates at 300 cards per minute.

One keyboard and one message printer are provided for operator-system communications. Keyboard permits entry of control and directive information to the system. Character-at-a-time printer prints instructions to the operator and replies to program status inquiries. Printing rate: 500 characters per minute. All 64 characters of Burroughs Common Language code can be printed.

A Calcomp 750 Magnetic Tape Unit and 565 Plotter.

NEL Systems Support Center

U.S. Navy Electronics Laboratory
San Diego, California 92152

A new computer facility known as the SYSTEMS SUPPORT CENTER has been established at the Navy Electronics Laboratory in San Diego.

Principal activity of the Center is to develop prototype programs for command and control systems, tactical data systems, and similar NEL projects. Development work has already started at the Center with a current staff of 20 programmers, engineers, and mathematicians, headed by Mr. Allen E. Beutel.

A unique feature of the Center is the capability to communicate with other computers and electronic equipment for system and subsystem simulation of environment, sensor outputs, display devices, weapon control, and similar functions.

The 36-bit 132K-word core, 2-microsecond cycle, type CP667 is the central processor. It is equipped with eight tape stations. Supporting computers are the CP642A/USQ20A, CP642B/USQ20B, and AN/USQ-17. A small high-speed peripheral computer with 8K blocks of memory and equipped with card read punch, paper tape read punch, and a line printer is used for off line work.

Computers and Centers, Overseas

Integrated Production Control Using Digital Computers

The English Electric Company Limited
London, W.C.2, England

The English Electric Company Limited was the main electrical contractor associated with the £32 million development scheme at The Park Gate Iron & Steel Company Limited, Rotherham, a TI Company. All the major items of plant are now in production. The scheme includes a new steelmaking plant comprising two Kaldo basic oxygen steelmaking units and a 75-ton electric arc furnace, a bloom mill with automatic programming equipment, a continuous slab and billet mill, a continuous narrow hot strip mill and all associated services. The development scheme will increase Park Gate's output of steel from approximately 425,000 to 800,000 ingot tons per year.

An outstanding feature of the project is the provision of integrated production control using three linked digital computers. This system is one of the most advanced examples of industrial computer control in the world and represents a major step forward in the use of computers in the steel industry.

The Metal Industries Division of English Electric, which has specialised experience in dealing with projects of this scope and size, undertook the co-ordination of the complete electrical installation including the computer and control systems. The main electric drives, the complete distribution and much of the auxiliary equipment was manufactured by the Company at its Works at Stafford, Bradford, Kidsgrove, and Liverpool; the English Electric Group also produced the three digital computers (English Electric-Leo Computers Limited), the tabular cathode-ray tube information display system (The Marconi Company Limited), and a comprehensive audio communication system (The Marconi International Marine Company Limited.)

The International Construction Company Limited acted as main electrical consultants.

INTEGRATED THREE-COMPUTER CONTROL

Production Planning

The production planning computer system has been designed as the first level of integrated computer control to undertake the main planning duties for the whole works covering operations from steelmaking to the finishing mills.

The main duties of the system are:

1. The grouping of incoming orders into suitable quantities for steelmaking while allowing for steel analysis, furnace availability, mill setup requirements, delivery commitments, and other factors.

2. The issue of appropriate working schedules to the various production departments.

3. The control of the progress of individual order items to ensure that specifications and delivery requirements are met.

These are essentially off-line computer duties and the system is arranged so that all relevant data on orders and work in progress is held on files which are processed and updated in periodic computer runs.

The computer used for this work is the English Electric Leo KDN2 and the system includes:

1. The central processor having 8192 words (24,576 characters) of fast access memory.

2. Four 40,000 character-per-second magnetic tape back-up memory units

3. High-speed and low-speed paper tape readers and punches for data input and output.

4. A high speed line printer.

Incoming orders, production reports and allocation data are transcribed on to punched paper tape on keyboard punches and verifiers. The system output is either in the form of printed schedules and progress cards produced by the line printer or as punched paper tape for transfer to the production control computer.

One of the important duties of the system is the production, at 2-hour intervals, of "pit tapes." These give all essential primary mill working data including ingot and order identification, rolling, scarfing, and cutting instructions.

Production Control

The second level of integrated computer control is applied through the on-line production control system in the primary mill area, that is from ingot reheat furnace to billet cooling banks.

The production control computer plays a major part in the system and its duties include:

1. The acceptance of pit tapes produced by the production planning computer,

2. Matching ingots drawn from the reheating furnaces to the appropriate order identity and processing requirements,

3. Tracking each ingot and its products through the primary mill area,

4. Display of current processing instructions and all relevant data to the operators,

5. Transfer of current shearing requirements to the billet shear computer,

6. Transfer of current rolling programme number to the bloom mill automatic programmer,

7. Collection of data on actual ingot weights and sheared bloom and billet lengths,

8. Preparation of a report tape for the production planning computer.

In contrast with the production planning system these duties are essentially on-line in that the computer must be continuously available to accept feedback data and use this to update display and other output at all times.

The computer provided is again the English Electric Leo KDN2 but for production control the system includes:

- The central processor with 8192 words of storage,

- High-speed and low-speed paper tape punches and readers for data output and input, particularly in exchanges with the planning computer,

- A specialised "Datapac" input/output cubicle to channel computer data to and from remote keyboards, weighing machines, the automatic bloom mill programmer, the billet shear computer and the display equipment,

- A special Marconi tabular display equipment having a central character generator and 10 cathode-ray display tubes on which essential data is displayed to the operators,

- The production controller's console which includes two of the displays and a full range of data input keys and switches and audio communication equipment by Marconi Marine to enable the production controller to supervise the operation of the system.

The computer controls the display system so that it shows the current portions of the production schedules with marker arrows to identify the item at each work station. It also raises queries on suspect feedback data, warns operators of coming changes, and displays messages selected by the production controller in emergencies.

Billet Shear Computer System

The third level of computer control, that is process control, is provided to direct the operations of the flying shear in the continuous slab and billet mill. The on-line shear computer completes the automatic chain which starts with the receipt of a customer's order and extends through the planning and production control systems to the actual cutting of that order. In so doing it not only ensures that the ordered items are cut with minimum waste but also that they are correctly identified. Confirmation of their cutting is fed back to production planning.

The most obvious value of the system lies in the reduction in tail-end waste. Slabs and billets are usually ordered in lengths which allow some tolerance; for example, slabs which generally have the longest tolerance may be ordered from 26 to 32 feet. The total billet length produced from each ingot will vary with ingot weight and processing losses and can only be measured after cutting. The computer system makes an accurate prediction of the total rolled length of each slab or billet, determines the cutting length resulting in minimum tail-end waste and feeds this as a cutting instruction to the shear control.

Thy system uses special infra-red sensitive photocells to measure the ingoing length and, with a puise counter, the elongation that takes place during rolling. The computer predicts the outgoing length as the product of these two measurements.

This computer is also the English Electric Leo KDN2 and the system includes:

- The central processor having 4096 words of fast-access storage,
- 85 special infra-red sensitive photocells arranged to make the necessary measurements on the hot slab or billet,
- A special Datapac input/output cubicle arranged to interpret the photocell signals as length measurement, exchange data with the production control computer, give cutting instructions to the shear control and printing instructions to the teleprinters, and
- Five teleprinters in special cabinets to print out bloom, slab, or billet identity on the cooling banks.

ELECTRICAL DRIVES

Kaldo Steelmaking Plant

The two 75-ton kaldo basic oxygen units are the first to be installed and in operation in the United Kingdom. The vessels are able to rotate about their axis of symmetry during oxygen blowing and are also able to tilt through 360 degrees to facilitate charging, sampling and tapping. Both movements are electrically powered.

Four specially developed English Electric 206-hp mill type 'CMR' machines are used for rotational movement. These are designed for the high currents used during the 60-second acceleration period while the vessel and its contents can be brought up to a maximum rotational speed of 40 rpm. Efficient cooling of the motors is arranged by forced ventilation air being fed through the centre of the tilting or 'Lantern' rings. Similar 200-hp motors provide the driving power for tilting the vessel to the various operating positions.

The generator arrangement takes account of the fact that rotating and tilting movements never occur simultaneously. This permits the use of a common generator with changeover contactors. Maintenance of supply is of paramount inportance and all drives are fed in parallel from the generators to give minimum disturbance should one of the motors fail. Load sharing between motors, equally important, is obtained by field trimming and load sharing resistors.

A comprehensive changeover arrangement is provided to allow rapid interchange of generator supplies with minimum interruption to the steel-making in the event of generator or M.G. set drive motor failure.

An interesting development undertaken by English Electric was the provision of a slipring unit for the transference of power supplies to the 'rotate' motors, which are mounted on the tilting frame itself, and to other electrical equipment on the vessel. A total of 8 sliprings suitable for currents of 1,065 amp during acceleration and 18 lighter current slipr.ngs are fitted as well as a heavy current earth continuity slipring. The complete unit is in a self-contained force-ventilated enclosure.

Bloom Mill

The 42 x 104 inch bloom and slab mill main drive is a twin motor arrangement giving a combined peak of 17,500 hp with a 50- to 120-rpm speed range. In line with modern practice, the top motor forward arrangement is used to obtain maximum access to the two machines and give a clean appearance to the installation.

Main power is provided via an Ilgner set consisting of a 5,000-hp slipring motor with associated 'Magamp'-controlled liquid regulator, 200,000 hp/sec flywheel, and four 1,400-kw generators.

Load sharing between the two motors and the four generators is ensured by a series-sandwich connection, facilities being included for differential torque adjustment between the two rolls to control the "turn-up" of the blooms. To provide what is an essential feature of a bloom mill—fast reversing control—static field excitation is used both for the generators and the main motors.

To enable the mill to operate in the most efficient and consistent way all operations can be pre-programmed and sequenced, with the exception of ingot tilting. Rolling programmes holding the information necessary for the automatic rolling of an ingot to the required bloom size pass by pass are stored in a mill static programmer. The rolling programme required is normally automatically selected by the production control computer but provision is made for manual selection.

The programmer uses a ferrite core store, similar to that used in digital computers, to store rolling data for up to 100 programmes of 35 passes. It is designed so that alterations to a programme or the input of new programmes can be made very simply.

Hot ingots are withdrawn as required from the ingot reheating furnaces and placed on to an ingot bogie. An English Electric control system automatically positions the ingot bogie adjacent to the particular furnace being discharged. The bogie delivers the ingot to the ingot weight under the control of the system and the ingot weight is recorded by the production control computer. The ingot is then transferred to the bloom mill on the ingoing roller tables.

Continuous Slab and Billet Mill

The continuous slab and billet mill has a split train. The two sections comprise a roughing section with two stands followed by a finishing section with four stands. The products of this mill are slabs up to 10-1/2 inches wide by 3-1/4 inches thick, and billets from 1-3/4 x 1-3/4 inches to 5 x 5 inches.

Mill stands are alternately vertical and horizontal, each stand being individually driven by a 1,400-hp 300-/750-rpm dc motor with a power supply from converter banks rated at 3,500 kw 700 v, one for each section of the mill. To maintain the high accuracy of speed matching needed and to minimise the effect of impact speed drop, each motor has a fast acting speed control loop in its field circuit.

A special feature of the mill is the use of an English Electric Leo KDN2 digital computer system to control the lengths of the slabs and billets cut by flying shear positioned on the outgoing side of the finishing train. (Full details of the billet shear computer system have been given above.)

Strip Mill

The continuous narrow hot strip mill comprises 12 horizontal stands driven by motors having outputs ranging from 375 to 1,125 hp and five vertical edging stands driven by motors with powers from 75 to 156 hp. The mill produces strips up to 10 in. wide ranging in thickness from 0.276 to 0.036 in.

In order to give maximum flexibility in setting of the speed cone, the motors are split into three groups, each group being fed from a separate 12-phase rectifier unit giving a total installed capacity of 7,375 kw at 750 v. Each horizontal stand motor and the last four vertical edging stand drives have fast acting speed holding controls to maintain the stand speed within close limits and to minimise the effect of impact speed drop.

To assist in maintaining correct strip control in the finishing stands where outgoing strip speeds of up to 3,000 fpm are reached, automatic looper control is included, which measures the loop lifter position and feeds correcting signals to the adjacent stand speeds if the loop deviates from the preset position.

Mounted halfway down the mill train (after horizontal stand No. 6) is the flying shear used for nose and tail cropping of the strip prior to its entry into the finishing stands. As the mill is continuous the shear has to make this out while the strip is moving at speeds of up to 460 fpm and therefore an extremely fast movement of the shear is needed. To obtain this the shear is driven by two mill type CMR 1,620 motors developing a total peak power of 2,800 hp fed back-to-back converter equipment. The motors reach their cutting speed of 500 rpm in 280 millisecs and decelerate in a similar time.

DISTRIBUTION AND ANCILLARY EQUIPMENT

Distribution Equipment

English Electric co-ordinated the design and installation of the complete electrical distribution and cabling system for the new scheme.

The maximum demand now imposed by Park Gate is of the order of 60 MVA. To meet this demand, and keep the fluctuations due to the 25 mva arc-furnace within reasonable limits, the entire works is fed directly from the national grid at 275 kv. Two separate supplies, via two 75 mva 275/33 kv transformers, feed a central 33 kv board. From these a radial distribution system feeds five 11-kv substations. These in turn feed 3.3 kv and 415-v power and lighting systems. Duplicate feeds and interconnectors are used extensively to ensure a reliable supply to all main boards in the plant.

Over 100 English Electric Class 'E' air-break circuit breakers are used in the 11- and 3.3-kv networks and there are also some 150 415-v Class-'M' air-break circuit breakers.

A notable feature of the system is the central control room where the 275- and 33-kv

switchgear and the 11-kv and 3.3-kv breakers associated with the bloom and billet mills may be remotely operated. A large mimic desk gives an instant indication of the position of all switchgear from 275 kv to 415 v throughout the plant and also provides remote control facilities to the operator in the event of a power failure.

Audio Communications by Marconi Marine

Efficient audio communication is of considerable importance in a steelworks of the size of Park Gate. In conjunction with English Electric, Marconi Marine have designed and installed a comprehensive communications system which embraces all production centres, pulpits, and control stations, maintenance engineers' offices and workshops, motor rooms and basements. The system enables speech to be heard clearly regardless of ambient noise levels and provides rapid calling facilities in unmanned areas.

The primary and strip mill sub-systems are entirely separate; each incorporates similar power amplifiers using the latest solid-state techniques. The circuits are split into 'rings' so that maintenance workers can carry on a conversation at the same time as one concerned with production with mutual interference. The rings can be connected together for general announcements.

The communications installation at Park Gate for crane operators is the only one of its kind in a steelworks. Inductive loop systems are used with production cranes to maintain the operator in touch with the ground regardless of the crane's position. Frequency modulated signals are superimposed on the loop system used with ingot charing cranes which enable the operator to open any one of the 20 ingot trailer doors from his cab.

Ancillary Services

As the main electrical contractor, English Electric was also responsible for the many other electrical services essential to the project. In conjunction with Park Gate, the complete high-efficiency lighting system (including the steel making plant, mill buildings, and external roadway illumination) was developed and its installation supervised.

English Electric also designed and supplied high and low voltage equipment for the control and operation of the water treatment plants for mill cooling supplies, ac slipring motors, and control gear for auxiliary duties throughout the plant. As part of the contract, the company handled the complete electrical installations (heating, cabling, lighting, and other supplies) in the offices, canteen, medical centre, and numerous other new buildings which are part of the Park Gate development.

ELEA 4001 System

C. Olivetti and C. S.p.A.
Laboratorio Di Richerche Elettroniche
Milan, Italy

The ELEA 4001 system, manufactured by Olivetti, follows the ELEA 9003 (Digital Computer Newsletter, July 1960) and the ELEA 6001 (Digital Computer Newsletter, July 1961). The ELEA 4001 is a general purpose system in which the connections with peripheral units have been studied with special care. The program develops under the control of micro-instructions which are permanently registered in a ferrite core memory. A manifold threading permits different functions in different times from the same position.

The main core memory has a capacity variable from 2.048 up to 16.384 alphanumerical characters with a memory cycle of 8 microseconds. Beside the data and the program, the memory contains the accumulator, the registers for address modification and the operational registers. Each character is represented by seven bits plus the check bit; it is therefore possible with this system to use the ISO international code with 128 characters and the result is a considerable compactness of 1 instruction which needs only 1 character for the operation code, 1 character to specify the modification register, and 2 characters for the address.

Data and instructions have a variable length: the words length is either specified in the instruction or indicated by a key-character. The instructions can consist of the operation code only or include all the relevant information. 128 channels are provided for connection with an

equal number of peripheral units; these units can include other ELEA 4001 computers, or other computers of a larger size.

The following units can be connected to this system: punched tape readers, tape punches, punched card readers, card punches, CMC7 magnetic documents readers, serial printers, parallel printers, printers with CMC7 magnetic characters, magnetic tape units, magnetic disc units, magnetic card units, enquiry stations, sensing and measuring units.

This system has a very high modularity and is suitable for the most different kinds of applications. For instance, by varying its composition, it is possible to obtain:

- low cost commercial systems with magnetic tape units,
- scientific computers,
- card-to-tape or punched paper tape-to-magnetic tape multiconverters for the transcodification and the organization of input data in a large size computer,
- off-line printing units relieving the main computer from the organization of the output data and their editing, and
- real time computers.

For these last applications the central processor analyzes the signals coming from the peripheral units and, according to this analysis, determines their priorities and controls their utilisation.

The peripheral units which can be connected with the 4001 system don't need to have special characteristics; on the contrary the 4001 system can be used to make compatible, after the necessary transformations or transcodifications, the differently coded information coming from different systems.

Olivetti, however, has studied a set of peripheral units particularly suitable to obtain from the ELEA 4001 the best performances at the lowest cost; they are:

- punched tape reader FL 400 with a speed of 400 char/sec, for 5- to 8-channel tapes;
- tape punch PN 50 with a speed of 50 char/sec which can punch 5- to 8- channels;
- MZ2 asynchronous parallel printer with a speed of 600 lines/min (80 or 102/120 positions per line), and 63 printable characters;
- MZ4 asynchronous parallel printer, provided with buffer, with a speed of 1100/2200 lines/min, up to 156 positions per line, 63 printable characters, and buffer of 1 character;
- CMC7 7200 serial reader which can read in 1 minute 300 documents inprinted with CMC7 magnetic characters;
- Sorter reader CMC7 7300 which can read and sort in 1 minute 300 documents inprinted with CMC7 magnetic characters;
- MZ2/CMC7 printer similar to the standard MZ2, with the additional possibility of printing also CMC7 magnetic characters at the speed of 300 lines/min;
- MZ4/CMC7 printer similar to the MZ4 with the additional possibility of printing also CMC7 magnetic characters.

The Basser Computing Department

University of Sydney
School of Physics
Sydney, N.S.W., Australia

The Basser Computing Department in the School of Physics, University of Sydney, Australia, has recently installed an English Electric KDF 9 computer. The machine has passed its acceptance tests and is now available for general use. The initial configuration of the system is as follows:

- 8K core memory (6 microsec. cycle)
- 1 paper tape reader (1000 charac./sec) 5, 7, or 8 channel
- 1 paper tape punch (110 charac./sec) 5, 8 channel
- 1 line printer (600-900 lines/min.)
- 3 magnetic tape units (40K charac./sec)
- 1 monitor typewriter.

The arithmetic unit which operates on a 16-cell "nesting" store has an add time of 1 microsecond.

"The principal programming language used is ALGOL, for which there are two compilers available. The first is a fast compile-slow execute interpretive scheme while the second, although taking longer to compile a given program, produces an optimised binary program. There is also a compiler available for USER CODE, a language for which there is a 1-to-1 correspondence with machine language.

"The Department still operates its first computer SILLIAC, but the use of this machine for general computation is not expected to continue beyond the next 12 months, because current programs will be converted to run on the KDF 9. A SILLIAC simulator has been written for the KDF 9 and is currently in operation.

"Among the main tasks which the new machine will be put to are the simulation of electron-photon cascades in absorbers, crystallographic analysis, processing and analysis of cosmic ray air shower and radio astronomy data, text analysis, and general student training."

Miscellaneous

Forecasting Solar Flares

Cornell Aeronautical Laboratory, Inc.
Buffalo 21, New York

Results obtained with an experimental prediction technique under development at Cornell Aeronautical Laboratory indicate that it may prove a useful tool in forecasting solar flares.

According to Albert Murray, project engineer at CAL, a multiple factor classification technique utilizing a general purpose computer achieved a forecast accuracy of 77 percent in predicting the occurrence (or non-occurrence) of a dangerous type of flare. The technique was experimentally applied to short-term prediction of flares associated with spectral Type IV radio emission produced by selected solar regions.

Sponsored by the National Aeronautics and Space Administration, Goddard Space Flight Center, the prediction project is part of a research effort to reduce the threat of solar radiation effects to the space exploration program.

Solar flares are sudden brief brightenings of the solar surface, indicating an unknown form of intensified activity. Type IV radio noise, emitted by some flares, is a sign that a shower of dangerous, high energy particles is also being released.

The ability to predict flares associated with Type IV emission and particle showers is desirable for a number of reasons. In addition to helping safeguard space travelers and space equipment, predictions could alert observers and contribute associated physical data for a detailed study of the electromagnetic events leading to a flare.

Essentially, the prediction technique consists of a decision formula composed of measurable variables and empirically determined weighting constants. When measurements are inserted in the formula, the resulting value of the formula indicates the probable subsequent occurrence or non-occurrence of a particle flare.

The variables used in the formula are factors reported or derived directly from instrument measurements and include such things as heliographic position, plage area, sunspot number, time of observation, and so on. Four-day histories of these factors were used with daily measurements for each factor.

"In the broadest sense, the weighting constants are like voting rights," Mr. Murray said, "serving to give a greater or lesser voice or influence to each factor."

The constants are systematically computed, using empirical statistical methods developed for pattern recognition or "learning" machines. They are computed in a "training" session in which their values are systematically adjusted in small increments until tests indicate that their use in the formula yields satisfactory forecasts.

Solar flare data were obtained from World Data Center A, High Altitude Observatory, National Bureau of Standards, Sacramento Peak Observatory and the Radio Astronomy Station at Ft. Davis.

The best achievement of the initial CAL experiment was a forecast accuracy of 77 percent in predicting the occurrence or non-occurrence of a Type IV flare in a given solar region within 4 days following a given 4-day history of region measurements.

Mr. Murray reports that though the degree of success is too modest to be of current operational value, it nevertheless suggests promise for a more elaborate method. He believes, he said, that this approach may at least contribute to a more detailed description of solar regions by underscoring certain interactions of observable factors.

The anticipated development of the technique at CAL will involve refinement of the decision formula with addition of new factors and weeding-out of weak factors. It is hoped that the new combinations will yield a greater forecasting accuracy and assist in further understanding the physical phenomena.

COBOL Usage

Board of Governors
Federal Reserve System
Washington, D.C. 20551

The Federal Reserve Board, Division of Data Processing, are finding COBOL of increasing usefulness for a wide range of statistical operations. COBOL compilation is now very satisfactory on our 1410. Although object programs frequently run well below autocoder speeds, the flexibility of COBOL and the ease of writing and debugging, even on the 1410, make it very attractive for an important range of applications. They are continuing to use autocoder only for large-scale recurrent production runs and strictly for ad hoc research applications.

PLATO II and III

The University of Illinois
Coordinated Science Laboratory
Urbana, Illinois

INTRODUCTION

The purpose of the PLATO project (Digital Computer Newsletter, Oct. 1961, July 1962, and Apr., July, and Oct. 1964) is to develop an automatic teaching system for tutoring simultaneously a large number of students in a variety of subjects. The central control element of the teaching system is a general purpose digital computer. The PLATO system differs from most teaching systems in that a single, high-speed digital computer is used to control all student stations. Thus, it can bring to bear the power of a large digital computer in teaching each student.

PLATO III PROGRAMMING

The first real use of the CATORES program (general PLATO III master program for any PLATO teaching logic) was made by the Scientific Inquiry project of Dr. Richard Suchman. The program, REPLAB, was completed this spring and 38 students successfully took the lesson. The student runs uncovered several small problems in CATORES and in the special subroutines written for REPLAB. These problems were easily soluble so the student use could continue, but as a result several CATORES improvements have suggested themselves which will be undertaken this summer. Some of these are on-line parameter input, restarting lessons at previous stopping points, improved doping routines, and the like.

The mathematical problem-solving program, the new PROOF, has many subroutines now ready for code checking with the PLATO complier.

Programming is underway to demonstrate the use of two entirely different lesson sequences simultaneously, one at one student station, one at another.

INQUIRY TRAINING (REPLAB)

REPLAB gives promise of being a tool for the multi-dimensional analysis of the inquiry process. As the subject operates this computer-controlled responsive environment, he is registering his patterns of inquiry and providing data that characterize his own particular patterns as an inquirer and as a thinker in general.

Preliminary analysis of the data on 27 sixth-grade subjects shows relationships between REPLAB variables that can be classed as cognitive style or mode of attack.

For the present, the most significant discrimination that can be made through the REPLAB analysis is between children who deal with their world more or less intuitively and in large global hunks and those who deal with it analytically in small segments. Several REPLAB variables seem to reflect how analytical the child is. For example, the number of times the subject reviews the problem film is negatively correlated with five outside test scores all of which reflect cognitive control. The two highest positive correlations are with measures that reflect looseness and fluency in cognitive performance.

Another example of a REPLAB variable that discriminates the tight focussed and analytical inquirer from the loose, diffuse and non-analytical one is the frequency of property

verification. This score is positively correlated with the outside measures of cognitive control and negatively correlated with the outside measures that reflect non-analytical thinking.

A factor analysis is presently being performed on 17 REPLAB variables and 37 outside variables to determine just what factors are present and how the REPLAB variables are able to identify these factors in the inquiry behavior of children.

INSTRUCTION IN PLATO LESSON PREPARATION

Work continues on the series of lessons to teach non-technical persons the operation of the PLATO system. The logic associated with the lessons has been outlined and is ready to be coded in PLATO compiler language. The former program, Perimeter of Polygons, used to demonstrate the tutorial logic is being updated and augmented to illustrate the wider range of flexibility in the PLATO III system. The latter program is to be used in conjunction with the new lesson-preparation sequence to instruct potential lesson writers.

PLATO III SYSTEM EQUIPMENT

During this quarter, work continued in the development and construction of circuitry required for the realization of a 20-student-station teaching system.

Circuitry constructed to date includes all circuitry required to operate only two-student stations. The remaining circuitry required for the operation of additional student stations is undergoing packaging.

Development continues on special circuitry which will update present circuitry or provide special system facilities. Included in this circuitry is transistor deflection, power control, master keyset, and master video switch circuitry.

PLASMA DISCHARGE DISPLAY TUBE

The purpose of the plasma discharge display tube is to develop a less expensive replacement for the present storage tube system. Work during this quarter has been directed towards the problem of races and firing of adjacencies within the array.

Communication Units-System 360

International Business Machines Corporation
White Plains, New York 10601

Real-time data communication service is a major characteristic of the IBM System/360 (see Digital Computer Newsletter, Oct. 1964). Advances designed into the system include simultaneous message handling, code conversion, and channel facilities for up to 248 communications lines supporting hundreds of terminals.

These facilities permit System/360 to handle minute-by-minute information on facets of business activity such as district sales activity, inventory levels, and process performance. Because it provides for timely collection and immediate use of data in an economic fashion, System/360 is highly suited to a wide range of application areas involving transmission of information.

Manufacturing management and control, online savings accounting, hospital information, process control, remote scientific problem solving, and sales order entry are typical of the applications the communications-oriented IBM System/360 can handle. A comprehensive range of input and output equipment, coupled with built-in communications facilities, makes this system far more suited to communications operations than previously available equipment.

ANSWERING AN INQUIRY

In an operating IBM Tele-processing network, several inquiries might simultaneously come into System/360 from distant cities concerning information which is contained in the disk file. The appropriate records would then be taken from the disk file and the appropriate responses would be prepared and returned to the originating cities.

Although this appears to be a simple function, it requires design balance to achieve the required variety of terminal speeds and functions. It requires simultaneous operation of many devices operating through a single economical channel. It requires the time-sharing and space-sharing programs which control

these devices. It requires the range of disk file capacity and speed. Furthermore, it has to do all these things concurrently with batch job processing.

System/360 has the data communications facilities to handle these functions as an integral part of its processing units. Special provision is made for code conversion within the processing units.

MULTIPLEX MODE

Multiplexor channel operation is the key to matching the computer's speed with economic data flow from Tele-processing terminals. It permits simultaneous message flow among as many as 248 lines. The channel accepts a one-character portion of a message from each communication line at a time. It scans from line to line, interrogating all active lines. The interrogation cycle—which takes place in millionths of a second—is repeated until all messages are completed.

Inside the computer, messages are properly assembled into separate main storage areas under the control of the multiplexor itself. The processor continues to operate on a batch program until the message is completely composed. At the end of message signal, the channel signals for an interrupt. When the interrupt is recognized as a communications request, the proper Tele-processing program is called to provide the required service.

The multiplexor channel can operate like a selector channel in "burst" mode. This limits the channel to one line at a time but increases the data flow to 200,000 characters a second.

Depending on the work to be done, the multiplexor channel can provide linkage for a few or a great many communications lines. Up to 248 communications lines can, for instance, be connected to the processing unit through some eight transmission control units. Each line can hold a great many separate terminals.

IBM System/360 Models 30, 40, and 50 are equipped with a multiplexor channel. Multiplexor operation on Models 30 and 40 is a collateral function for the logic circuits. That is, circuits are borrowed from normal duties as each character is taken into the processing unit, then returned to the program being run at the time. This interleaving of functions provides both logic and channel functions with the same circuits. The multiplexor channel in Model 50 consists of circuits reserved for this function.

Multiplexor channels are not provided on Models 60, 62, and 70. A large installation might, however, employ one of the more powerful models as a central processing system while a smaller model services communications inquiries. The two systems could be linked through their channels or through a file. The effect would be to have the smaller model of System/360 predigest communicated messages which would then be passed to the larger model's domain for storing, record updating, information retrieval, or special program processing.

STORAGE PROTECT

Since the communications-equipped System/360 is always ready for service to remote terminals, no matter what application program is operating, its storage protect feature is important. Each address is examined before servicing its storage request.

An identification used for each terminal indicates a storage space where the new entry must go. If there is a conflict with another key, the machine reverts to an error condition and calls in a special routine.

System/360 provides a standard interface for Tele-processing control units, data terminals, and input and output units. This is important for the installation whose needs are growing. When a more powerful processing unit is required for an installed System/360, there will be no impact on the Tele-processing system. The new unit can be attached in the same way as the smaller one without change to control units or terminals.

TRANSMISSION CONTROL UNIT

A transmission control unit—the IBM 2702 transmission control—attaches to the multiplexor channel so that the channel can be linked with data terminals. Up to four transmission control units can be attached to the multiplexor channel of the System/360 Models 30 and 40, and up to eight on Model 50.

The basic 2702 transmission control unit provides 15-line, half-duplex service (send then receive capability as opposed to the fully-duplexed line's simultaneous send and receive capability). An optional feature permits expansion of the 2702 transmission control unit to 31 lines. Maximum line speed of the basic 15-line unit can be increased to 710 bits per second.

Terminal types which can be attached include IBM 1030, 1050, and 1060 terminals, the IBM 1070 process communications system.

The IBM 2701 data adapter unit expands the input and output capabilities of the IBM System/360. It connects a variety of remote and local external devices to any System/360 configuration.

The IBM 2701 can be attached to either a selector channel or multiplexor channel.

The parallel data adapter feature allows external devices to connect to the 2701 through a half-duplex mode—transmitting and receiving information in one direction at a time. This feature contains 11 control lines and 16 data lines and can be expanded up to 48 data lines in increments of eight.

Another feature, designed primarily for the handling of telemetry data, permits the 2701 to handle up to two million bits a second. Other 2701 adapters enable switching of electrical contacts under computer control, determination of the status of a particular test instrument during a process control job, and control of data transmission between the computer and private wire terminals or 1050 data communication systems.

How Successfully Can Computers Identify Subjects in Natural Language Text?*

Institute for Scientific Information, John O'Connor
Philadelphia, Pennsylvania 19103

The searching of natural language text by computer to find papers about specified subjects has been suggested in the literature. An important special case of this procedure, computer assignment of subject indexing terms to papers (automatic indexing), has been widely discussed. When the title of a paper is the only part of its text processed, and the processing consists of selecting each title word not on a list of "useless words" (such as "the", "of", "study", and the like), automatic indexing reduces to production of a permuted title (or KWIC) index. Permuted title indexes are now widely used, and further use of them is often suggested.

Nonetheless it is not clear how effective computers can be for searching natural language text. There have been some studies of the question, and more are needed. In particular, it is important to examine subject-paper pairs for which particular proposed techniques fail. This could have been emphasized more in previous studies.

A study with such an emphasis is sketched here. The subject was an information retrieval system, serving a pharmaceutical research laboratory, for which papers had been indexed by subject specialists. The question was whether a computer could duplicate this "cerebral" indexing. Two index terms were studied intensively: toxicity (mostly drug toxicity-undesirable side effects of drugs) and penicillin.

The principal results of this study will be reported in a journal article; however, several results are described here briefly:

1. It has been widely suggested that computers can adequately identify subjects in natural langauge text if provided with a suitable thesaurus. For instance, the thesaurus entries for toxicity might include the following:

- Inflectional variants, such as "intoxicate";
- Synonyms, such as "poison";
- Names for specific kinds of toxicity, such as "salicylism";
- Expressions meaning drug toxicity, such as "side effect"; and
- Expressions which in pharmaceutical literature usually mean drug toxicity, such as "untoward effect".

In general, a thesaurus entry for a subject is a list of words or phrases which are clue expressions. One or more of them in a paper makes

*Research sponsored by the Information Systems Branch, Office of Naval Research (Contract Nonr 4183(00)) and by the Information Sciences Directorate, Air Force Office of Scientific Research (Contract AF 49(638)1300).

it probable that the subject occurs in the paper. Of course such clue expressions are useful only if they recur in papers beyond those in which they were first found during construction of the thesaurus. Otherwise they have no predictive power.

Some toxicity papers contained no clue expressions likely to recur in other papers. For instance, the title of one paper was "Partial Sterility Following Oral Administration of Sulfaguanidine in the Male Rat," and the text of the paper used only similar or more complex patterns of words to report the drug's effects. Of the 62 toxicity papers, 8 were of this kind; to put it very briefly, thesaurus methods are not sensitive enough.

2. The majority of non-thesauric toxicity expressions consisted of some disorder word (sterility, died) and some substance or substance-contact word (cortisone, administration) related by 1 of about 20 connectives (following, result in, and so on). Requiring a particular order (such as disorder word before "caused by"), and weighting for word distance permitted identification of all toxicity papers missed by clue words. Computer use of this method would require provision of lists of disorder and substance words, perhaps produced by scanning medical dictionaries, drug handbooks, and some other sources ("administration" was in neither of two standard medical dictionaries).

But some toxicity expressions did not have "connection forms" such as those just described, nor appear to have any other mechanizable form sufficiently general to have predictive power. For example: "Animals which received cortisone either with or without isoniazid developed generalized tuberculosis." Cortisone or corticotropin raises the level of cholesterol in the blood to an abnormal degree. A toxicity paper which described toxic effects only by such sentences would be completely missed by the method of connection forms as well as by thesaurus methods.

3. Clue words and connection forms selected some papers which said nothing about toxicity. For example, a drug "toxic to bacteria" is not necessarily an instance of drug toxicity. And "cortisone has produced highly successful results in disorders" does not describe drug toxicity. About 7 percent of all papers searched would be wrongly selected by such "accidental selection," judging from a sample of 200 papers.

A paper could say something about drug toxicity which was not new and therefore not indexed under toxicity. An example is the heading: "Effects of antihistamine drugs on ventricular arrhythmias induced by aconitine." Weighting more heavily those thesaurus word and connection expressions which occurred in titles, headings, and summaries helped prevent selection of very many such papers. Nonetheless, judging from the sample of 200, about 6 percent of all papers searched by computer, using thesaurus and connection form methods, would be falsely selected for this reason.

It would appear that only a miscellaneous set of specific, ad hoc modifications would be capable of significantly reducing false selections in the sample studied. In other words, no general and predictively powerful method appeared applicable.

In the pharmaceutical retrieval system, toxicity is a frequently used term, which is applied to 13 percent of the collection. (Of course in index searches it is always used in combination with other index terms.) The preceding paragraphs indicate that the thesaurus and connection form methods which might select these toxicity papers would also select about as many more unwanted papers. Whether this would be too many for practical purposes is a complicated matter which cannot be discussed here.

Vigilometer and Computer Techniques Aid Psychological Studies

National Bureau of Standards
Washington, D.C. 20234

INTRODUCTION

Engineers of the NBS Institute for Applied Technology (U.S. Department of Commerce) have designed a computer-type research apparatus to determine how the monitoring performance of Army personnel is affected by such factors as time on duty, distractions, and the characteristics of displays being monitored. The machine, known as a Vigilometer, was developed at the Institute for the U.S. Army Personnel Research Office (USAPRO) to simulate a wide range of visual and auditory monitoring tasks, and to measure the effectiveness of

monitoring personnel under a variety of conditions.

The key design engineers responsible for achieving the Vigilometer's operational requirements were Ernest Ainsworth and Philip Shupe of the NBS Information Technology Laboratory, working under the direction of James P. Nigro. The functional requirements and major performance specifications of the Vigilometer were developed by Dr. John G. Tiedemann, Monitor Performance Task Leader, USAPRO, to meet U.S. Army research requirements. Also instrumental were Dr. Delaney A. Dobbins, former Task Leader, and Dr. Philip J. Bersh, Chief of USAPRO's Combat Systems Research Laboratory. Findings obtained with the Vigilometer will help U.S. Army research scientists improve work methods and identify vigilant personnel for monitoring jobs.

The importance of vigilance in performing crucial duties has been recognized by armies at all times the world over, as attested to by the traditional death penalty for the sleeping sentry. Vigilance remains a problem, although today's sentry often stands watch over a radarscope or is aided by an electronic alarm system. The difficulty of remaining alert has ever been increased by the remote character of the warning and the relatively passive participation of the observer.

The USAPRO Vigilometer Laboratory will study the alertness and reliability of men standing watches on monitoring instruments. The Vigilometer controls stimulus situations and records the responses of up to five subjects at a time. Analysis of the responses will help Army behavioral scientists to relate monitor performance to such factors as environmental constraints, supervisory controls, fatigue, distraction, and the type and pattern of display. The findings will be useful in the field of personnel utilization, particularly in specifying optimum work methods and conditions.

THE VIGILOMETER CONSOLE

The Vigilometer is actually two machines in one, the first programming the timing and magnitude of both critical and distracting stimuli and the second recording the responses of the subjects. Its essential circuitry, contained within a console the size of a large desk, controls the display instruments at the test stations and records the results. The experimenter merely inserts a paper tape, which he has previously punched or selected for the desired stimulus program, into the tape reader and starts the machine in its programmed sequence of stimuli. A library of taped programs can be built up for the various programs used and new ones can be punched when needed.

TEST STATIONS

Each of the five subject test stations at the Vigilance Laboratory is in a soundproof "isolation booth" connected to the console by 5 cables which carry 25 subchannels, each a stimulus-response set. The subjects being tested are told what constitutes a critical stimulus—perhaps a red light, an audible 1000-Hz buzzing, or a galvanometer deflection greater than three divisions from center, for example—to which each subject is to respond by pushing a button on the stimulus module of his station. The subjects are then seated in individual booths and exposed to the series of stimuli, some critical and others noncritical, until the halt command on the tape ends the experiment.

Each test station consists of a number of paired indicators and response buttons, one kind of indicator to each module mounted in the station equipment rack. The instrument modules supplied with the Vigilometer are of five types, having as their respective instruments or indicators (1) a nullmeter, (2) an oscilloscope, (3) three pairs of red and green warning lights, (4) a five-digit alpha-numerical display, and (5) an auditory presentation by loud-speaker or headset. A sixth type of module has a clock on its panel but is not used in evoking responses. The types can be selected and located in the rack's 24 pigeonholes to best suit the needs of the experimenter. Each module contains on its 6-inch-square front panel its instrument or indicators and the associated pushbutton(s) for responding to critical stimuli. The module is electrically connected, when it is pushed all the way in, by a connector at its rear mating with a console module connector; the module can then be locked in place.

RECORDING DATA

The Vigilometer includes a printout device to record the individual responses and totals of response types. This device is operated by the computer portion of the machine, which categorizes each response according to whether it was associated with a critical signal, noncritical signal, or no signal, and tallies each response received by type, subject (station), and channel (each accommodating up to five instruments). The machine also tallies each stimulus on registers for critical and non-critical stimuli

on each channel, raising to 85 the number of registers maintained in the machines.

The printer prints intermittently one line for each signal or response on a paper tape from the time the Vigilometer is placed in operation until it reaches the halt instruction. It prints each line of nine characters simultaneously in 0.2 second; identifying the station (one of five), the channel (one of five), the type of response (one of three), and the time in centiseconds since the last response on that channel.

Each response received is first read into the "printer backlog" section of the machine's memory. The printer scans the memory after each operation, and repeatedly while not printing, to pick up new data to be printed.

The printer not only produces a description of each response, but on receiving a summary printout instruction from the taped program prints a summary of the 85 categories of data stored, including both response and stimulus data on each of the 5 channels. This instruction not only can be given just before the halt instruction, but also can be encoded at any desired intermediate points on the program tape or can be manually called for at any time by the experimenter. On receiving this order during the stimulus program, the printer produces a printout of all 85 lines of cumulative data in 15 seconds and then goes on to print any further data that have been stored in the printer backlog memory during this operation.

VARIATIONS IN INSTRUMENTS

The many modules and their possible locations at each station permit evaluation of the effects of instrument location, sensitivity to competing stimuli, and the distraction potential of various modes. Experimentation with such variations makes it possible to recommend the best presentation of stimulus material for various Army monitor jobs.

Studies can also make use of programmable variations in stimulus detail. Not only can the clock be run at accelerated rates, but 1 of 9 warning light intensities can be used, 1 of 19 possible deflections of the nullmeter, 5 audio frequencies for auditory presentation, and 8 amplitudes. The pulses displayed on the oscilloscopes can be varied in position, width, and amplitude so that the pattern presented is under machine control. Experimentation will permit U.S. Army Personnel Research Office psychological investigators to determine threshholds and equated amplitudes for the stimulus types studied. More types of modules can easily be added as required for studies using the Vigilometer.

Computing Time Available on CDC 3600/160A

The National Center for Atmospheric Research
Computing Center
Boulder, Colorado

To further atmospheric and related sciences, the National Center for Atmospheric Research is making computing time available to outside scientists. Some time will be available without cost and the rest will be at cost. The problems may be in such diverse fields as turbulence and convection, cloud physics, stellar evolution, radiative transfer, general circulation, and the like.

The computer, a CDC 3600, is located in Boulder, Colorado. It is one of the fastest computers, has 32K 48-bit words of memory and is equipped with 8 IBM-compatible high-speed tape drives. It's powerful order set includes double-precision operations. The input/output processing is done on a CDC 160-A system which includes a 1000 line-per-minute printer, a 1200 card-per-minute card reader and 2 tape drives.

Problems will be accepted from scientists at non-profit research institutions. The problems must have been coded in FORTRAN II, FORTRAN IV, COMPASS, or 3600 FORTRAN. Further information and applications can be obtained from Dr. Glenn E. Lewis, Director of the NCAR Computing Facility, National Center for Atmospheric Research, Post Office Box 1470, Boulder, Colorado.

On-Line Shock Research

University of Southern California
Los Angeles 7, California

INTRODUCTION

Shock research at the University of Southern California is paying off. Investigators at the USC School of Medicine have shown that the dread state of circulatory failure known as "shock" can be safely studied in humans and that there are more kinds of shock than previously known. They have found a means of evaluating the severity of a patient's condition and have improved methods of treatment for several types of shock.

The USC Shock Research Unit was established under a $423,476 grant from The John A. Hartford Foundation, Inc., of New York in November, 1961, and placed in 24-hour-a-day operation in April, 1962. Located in Los Angeles County General Hospital, where USC treats patients and does clinical teaching, the unit is specially equipped for care and study of patients in shock.

SIGNIFICANT FINDINGS

In a report on the first 2-1/2 years' progress at the unit, Dr. Clayton G. Loosli, USC medical dean, said early findings were so promising that they drew $870,000 in additional support from the U.S. Public Health Service to provide an IBM computer system to handle data generated by the study. A proposal for continuing support from The Hartford Foundation is under consideration, he said.

The Shock Unit team summarized their more significant findings from approximately 400 patients, more than 300 of them in shock, as follows:

- In shock associated with an overdose of barbiturates or following anesthesia, an absolute fluid loss is a major factor. By administering fluids to restore normal volume, the USC group has considerably improved the results of treatment. In such cases, the blood vessels are initially constricted, as they are in most other types of shock; however, after fluid is administered, constriction is relieved.

- The presence of excess lactic acid in comparison to pyruvic acid is a valuable index to the severity of shock and to the patient's likelihood of recovery. The acid buildup occurs when the oxygen supply to the cells is sharply reduced.

- Animal studies in the unit's physiological laboratory suggest that the traditional head-down position often recommended for persons in shock does not appear to help and may be harmful since, with the head lower than the feet, breathing must be done against the pressure of the abdominal contents. This finding is being tested in the human patient.

- A condition termed "pseudoshock" results when central venous pressure rises in conjunction with failure of normal heart function. As the heart action is restored by medication, particularly the heart stimulant—digitalis, venous pressure drops and blood pressure rises to normal.

At the 3500-bed Los Angeles County General Hospital, more than 1000 patients die each year after protracted shock. The seriousness of the problem is comparable in private hospitals. Physiological mechanisms of shock are poorly understood, and the very term "shock" is open to different interpretations.

To study shock in man, USC equipped a special ward in the County Hospital where patients in shock spend an average of 42 to 78 hours. The ward accommodates up to three patients at a time, with a physician, nurse, and technician always on duty. Patients are admitted to the shock ward by attending physicians at the County Hospital, primarily from the surgical, medical, and obstetrical services.

Measurements of the patient's blood pressure, heart contractions (EKG), heart output, heart rate, respiratory rate, and temperature at five points on the body are monitored continuously and are read out every 5 minutes, unless some sensed value exceeds a previously set up high-low variation limit. In this case, the ward personnel may select another mode of computer operation in which the variables of interest are more frequently listed and plotted. Through the use of the large memory available with the disk file, the programming for the computer is made up of many stored subroutines which are organized by an executive routine to provide needed versatility.

THE IBM COMPUTER SYSTEM

The computer system, Fig. 1, is a unique aid to the research and attending physicians in

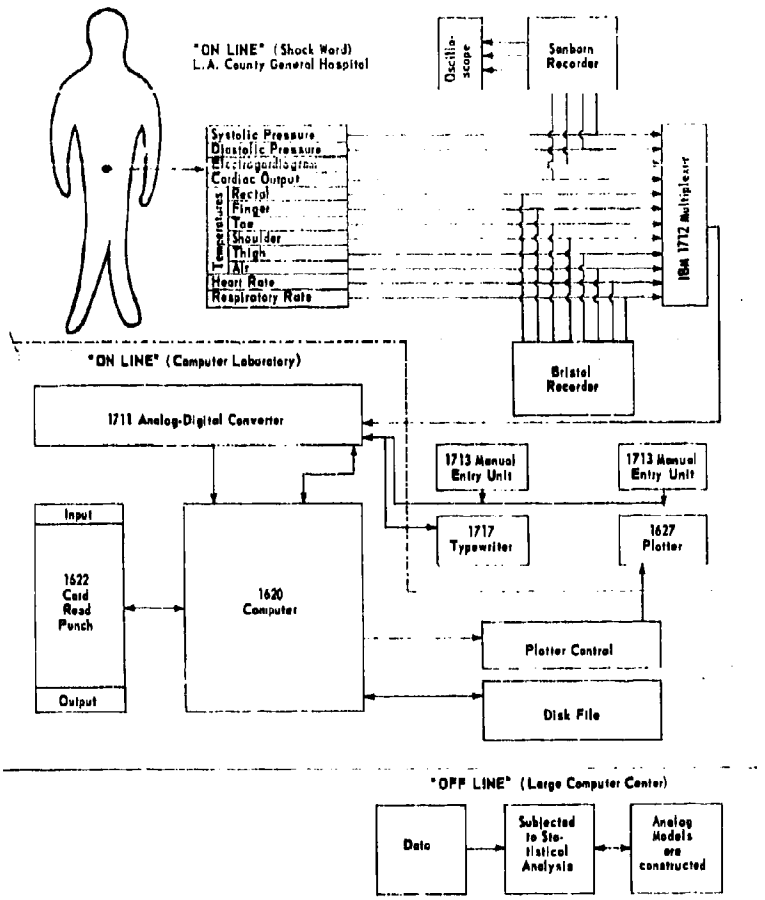

Fig. 1. Data Flow Diagram

the unit as it continuously monitors several vital functions in each patient. The system has been programmed to a ert personnel on duty to any significant change in the patient's condition.

This is believed to be the first instance of critically-ill patients being "on-line" with a computer for immediate retrieval of essential medical data. The data are transmitted from the patient to the computer and from the computer back to bedside (it is also stored for later use in research) where doctors may use it in determining treatment in a matter of seconds, whereas it would require several hours to obtain by the use of desk calculators. Since many aspects of the patients' physiological condition are measured separately, studies may be made of the effects of treatment on each one. An oscilloscope at bedside gives a continuous reading of blood pressure, EKG, and heart output.

The system, designed with IBM's assistance and operated jointly by USC's Schools of Medicine and Engineering, is built around an IBM 1620 solid-state, variable word length, medium sized computer with a 20,000-bit, fast-access memory. Transducers (sensors) attached to the patient generate data which produce signal voltages that are, in turn, fed into an IBM 1712 multiplexer unit, located in the ward. The data signals are then sent via cables down the hall about 100 feet to the computer laboratory where an IBM 1711 analog-to-digital converter turns voltage levels into discreet digital values. These are fed into the computer by interconnecting cables. In addition to the sensor input, manual input units are provided in the ward so that personnel may feed laboratory determinations, patient histories, medication instructions, and other data into the computer.

The computer has previously been told through programming what to do with the various data fed to it. The reduced values are punched out on cards by the IBM 1622 read-punch unit or are displayed in the ward on an

automatic plotter under computer control. Connected to the computer is an IBM 1311 disk file which provides ready access to 2,000,000 bits of memory.

ACKNOWLEDGMENTS

The importance of shock as a clinical problem is widely recognized, and studies are being conducted in similar units at several university medical centers. Significant research on shock has been done for many years at the University of Minnesota, where Dr. Max Harry Weil, associate professor of medicine and director of the Shock Research Unit, received his post-doctoral training.

Working with Dr. Weil, who is principal investigator on the Hartford-sponsored project, are co-principal investigators Dr. Leonard Rosoff, associate professor of surgery and chief physician in surgery at County Hospital, and J. Howard Carrington, administrative program director. Others are co-investigators Dr. Herbert Shubin, assistant clinical professor of medicine; Dr. Edward C. Bradley, instructor in medicine; David Stadelman, head of the computer section; and Frank B. Cramer, statistician. Vasant N. Udhoji is a research associate on the project, and Dr. James S. Taylor is a research fellow.

The future goals of the project, according to Drs. Weil and Rosoff, are to increase the understanding of shock and to find improved methods of treatment.